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REVIEW OF GROUNDWATER AND SEEPAGE RECOVERY 1993 – 2005 FIMISTON I AND FIMISTON II TAILINGS STORAGE FACILITIES

Report prepared for:

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TABLE OF CONTENTS

LIST OF FIGURES

1 INTRODUCTION

Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM) manages the mining and ore processing operations at the Fimiston Open Pit (Kalgoorlie Super Pit) and Mt Charlotte Underground gold mines on behalf of joint owners Barrick Gold of Australia Ltd and Newmont Australia Limited. KCGM was formed in 1989 by the amalgamation of several small scale mining operations along Kalgoorlie's Golden Mile ore body.

Gold ore from KCGM's mining operations is processed at the Fimiston Mill which is located on the eastern side of the Fimiston Pit. Tailings generated by the Fimiston Mill are currently directed into the Fimiston I and Fimiston II Tailings Storage Facilities (TSFs) (Figure 1).

Tailings disposal by KCGM in the Fimiston I and Fimiston II TSFs has caused groundwater mounds to develop in the natural formations surrounding these TSFs. KCGM has been managing seepage from these facilities since 1993 by monitoring groundwater levels and hydrochemistry, and recovering a mixture of native groundwater and seepage using production bores and trenches (Figures 2 and 3). The groundwater production and monitoring facilities are collectively known as the Eastern Borefield.

In 2005 KCGM prepared a Seepage and Groundwater Management Plan to oversee the planning and management activities associated with controlling groundwater around the Fimiston I and Fimiston II TSFs (KCGM, 2005). This plan was implemented in the last quarter of 2005, and requires KCGM to collect particular data and prepare reports presenting the results of monitoring and management activities.

KCGM is proposing to expand the Fimiston mining operations (mine, waste dumps, and TSFs), and is preparing documents in support of this proposal for submission to the Environmental Protection Authority as part of a Public Environmental Review.

Options being considered for storing the increased volume of tailings associated with the Fimiston operations expansion proposal include recommissioning of the Kaltails TSF, and increasing the maximum permitted heights of the Fimiston I and Fimiston II TSF.

This report presents a summary of KCGM's groundwater monitoring data and management activities that have occurred for more than a decade at their Fimiston I and Fimiston II TSFs. The report is intended as supporting documentation for KCGM's proposal to expand the Fimiston mining operations. Data collected to December 2005 are included within the scope of this report.

2 SETTING

2.1 Topography and Surface Water Hydrology

The Fimiston I and Fimiston II TSFs are located in a catchment of Hannan Lake, which is a saline playa lake located about 10 km south of Kalgoorlie. This catchment is about 18 km long and between 8 km and 13 km wide. Land surface elevations range between 320 mAHD at Hannan Lake to over 400 mAHD at some of the catchment divides. Surface gradients range between 3 m/km parallel to the central floodway to over 10 m/km across the catchment.

Significant amounts of surface water flow through the central floodway of the catchment only after heavy rainfall events. Heavy rains associated with tropical depressions in 1992, 1995, and 1999 caused extensive flooding in the Kalgoorlie area, and on these occasions floodwaters between the Fimiston I and Fimiston II TSFs spread laterally over several hundred metres.

2.2 Geology and Hydrogeology

The shallow stratigraphic sequence within the catchment consists of sedimentary deposits and underlying weathered bedrock. The main aquifer of interest lies within the shallow sedimentary deposits above the bedrock.

Most of the bedrock sequence within the northern and central parts of the catchment is Black Flag Beds, which is a formation composed of very fine grained and dense sedimentary deposits. In boreholes around the Fimiston I and Fimiston II TSFs the Black Flag Beds is typically very weathered with most samples appearing as very fine sand, silt, and talcy clay. Mafic and ultramafic volcanic rocks occur on the ridges which form the western and eastern divides of the catchment.

The Black Flag Beds typically has a very low hydraulic conductivity and does not form a significant aquifer. The mafic and ultramafic rocks on the ridges bounding the catchment are also not known to be significant aquifers.

The sedimentary deposits which overlie weathered bedrock in the catchment correlate with similar deposits around Hannan Lake and elsewhere in the Eastern Goldfields. Near the Fimiston I and Fimiston II TSFs these deposits have a maximum thickness of about 30 m and pinch out to the east and west towards the bedrock ridges which form the catchment divides. These units consist of varying mixtures of clays, sands, and gravels. Secondary ferruginous deposits (ferricrete) often occur as layers above more massive and dense clay.

In the vicinity of the Fimiston I and Fimiston II TSFs, the layers of sand, gravel and ferricrete often have moderate hydraulic conductivities and can form an aquifer when saturated with groundwater. The combined thickness of these layers generally ranges between about 2 m and 10 m.

The shallow groundwater system in the catchment is recharged naturally after significant rainfall events that cause surface water to collect and flow down the central floodway. Smaller amounts of recharge would also occur by infiltration of surface water in the several stream channels on the flanks of the catchment.

Natural groundwater in the catchment is saline, with total dissolved salts (TDS) concentrations in the range of 20,000 mg/L to 60,000 mg/L. TDS concentrations in excess of 100,000 mg/L occur in some areas adjacent to the TSF walls where seepage has occurred. The natural groundwater is very acidic, with pH generally less than 4.

2.3 Tailings Storage Facilities

The Fimiston I TSF was commissioned in 1988, and the Fimiston II TSF was commissioned in 1991 and extended in 1995. The Oroya TSF was commissioned in 1974 and ownership was transferred to KCGM in 1989. KCGM began tailings disposal in the Oroya TSF in 1989, and decommissioned this TSF in 1995.

The Fimiston I and Fimiston II TSFs are divided into “paddocks” which receive tailings on a rotating basis. Tailings are pumped from the Fimiston Mill as a slurry containing about 50% solids and 50% liquid by weight. The solids are typically fine grained sand and silt sized particles less than 150 μm in diameter. The liquid component is a solution of hypersaline water (>100,000 mg/L total dissolved salts concentration) and several chemicals including lime and cyanide.

The TSFs are developed by progressive deposition of solid residues from the slurries. Tailings are discharged from spigots around the perimeter of each TSF. The solids settle and form gently sloping “beaches”, and the water pools in the central areas of the TSFs. Some of the water is collected by the TSF decant systems and is re-used in the ore processing circuit, some evaporates, some is held within the fine matrix of the tailings, and some seeps into the underlying formations.

3 EASTERN BOREFIELD

3.1 Production Bores and Trenches

The Eastern Borefield has been established progressively since mid-1993, and by December 2005 consisted of 116 production bores. Groundwater is also being

intercepted by five trenches [Fimiston I North, Fimiston I South, Fimiston II North, Fimiston II (includes B Trench), and Fimiston II South (includes C Paddock South Trench)]. Significant amounts of groundwater seepage into the trench at the Oroya TSF ceased in mid-1996, and this trench has since been backfilled and the surface rehabilitated. Bore locations are indicated on Figure 2, and trench locations on Figure 3.

The following table summarises the history of production bore installation and commissioning in the Eastern Borefield:

Period	Number of Production Bores Commissioned	Total Number of Production Bores
1993	2	2
1994 and 1995	12	14
1996 and 1997	20	34
1998 and 1999	17	51
2000 and 2001	41	92
2002 and 2003	17	109
2004 and 2005	7	116

Production bores in the Eastern Borefield range in depth between 12.5 m and 32 m below natural surface, and draw groundwater from the shallow alluvial/colluvial aquifer. Some production bores have been constructed on the outside walls of the Fimiston II TSF, and have cased depths of up to 50 m.

All groundwater produced by the Eastern Borefield is saline, and is used by KCGM for ore processing at the Fimiston Mill.

3.2 Groundwater Monitor Bores

KCGM currently maintains eighty four groundwater monitor bores in the vicinity of the Fimiston I and Fimiston II TSFs and the catchment that includes these TSFs. Monitor bores at seven other sites are no longer accessible because they have been covered by waste dumps. Monitor bore locations are indicated in Figure 2.

The cased depth of the monitor bores ranges between 7.5 m and 30 m below natural surface. Monitor bores in the central floodway area between the Fimiston I, Fimiston II, and Oroya TSFs have slotted casing within the shallow alluvial/colluvial aquifer. Most monitor bores in the northern part of the catchment and on the flanks of the catchment have slotted casing exposed to the Black Flag Beds. All monitor bores are completed with annular seals and locking caps.

3.3 Seepage and Groundwater Management Plan

The Seepage and Groundwater Management Plan (SGMP) was prepared by KCGM in response to an independent review of their proposal to increase the maximum permitted height of the Fimiston I TSF from 30 m to 40 m. The SGMP describes the planning and management activities associated with the operation of the Eastern Borefield.

The SGMP establishes standards and sets performance targets for the Eastern Borefield. Standards cover items such as licence conditions and the construction of new bores. Performance targets specify particular data to be collected, and reviews or reports that are to be prepared. KCGM's activities within the scope of the SGMP are subject to independent audit and review annually.

The SGMP identifies the vegetation assemblages in the area as the main environmental value that requires protection from the adverse effects of TSF seepage. KCGM's objective in this regard is to control groundwater levels and prevent the root zone of the vegetation from becoming saturated. The SGMP has established minimum acceptable depths to the water table and trigger (action) levels of 4 m and 6 m. When monitor bore data indicate the water table is rising and approaching these depths, action is taken to increase the groundwater pumping rate and arrest or reverse the rising groundwater level trends.

The SGMP has established the objective of reducing groundwater levels in the vicinity of the Fimiston I and Fimiston II TSFs to historic levels that occurred prior to KCGM's tailings disposal operations. This is a long term objective that will require the Eastern Borefield to be operated for a period after tailings disposal into the Fimiston I and Fimiston II TSFs has ceased.

The SGMP will be revised as necessary if the Kaltails TSF is recommissioned as a result of the Fimiston operations expansion proposal.

4 GROUNDWATER MONITORING DATA

KCGM monitors groundwater pumping rates from the production bores and trenches, groundwater levels in the monitor bores, and groundwater chemistry from the monitor bores and all production bores and trenches. These data are discussed in the following sections.

4.1 Groundwater Production Data

Graphs of the annual and cumulative volumes of groundwater produced by the Eastern Borefield since 1993 are presented in Figure 4.

Annual production steadily increased from 18 ML in 1993 to 2,289 ML in 2001. Similar amounts of groundwater were produced during 2001 and 2002, and production again increased steadily from 2,276 ML in 2002 to 2,701 ML in 2005. The average daily production rate of the entire borefield during 2005 was 86 L/sec (7.4 ML/day).

The total volume of groundwater produced by the borefield to 2005 is 19,155 ML.

4.2 Groundwater Level Data

The primary purpose of the Eastern Borefield is to control groundwater levels in the vicinity of the Fimiston I and Fimiston II TSFs. Groundwater levels in the area respond to recharge from TSF seepage, natural recharge in the catchment from rainfall, and groundwater production by the Eastern Borefield.

Figure 5 presents contour plans of groundwater levels in the area in 1995, 2000, and 2005, and contour plans of changes in groundwater levels that occurred over the five year periods ending in 2000 and 2005 are presented in Figure 6. The locations of the production bores and monitor bores that were established at the particular times are also indicated on Figure 5. The distribution of the production bores indicated where pumping was occurring at the time, and the monitor bore distribution indicates where groundwater level data are available for the development of contours (ie, where “data support” is available for the contour plans). As indicated by Figure 5, more production and monitor bores have been established over time as the Eastern Borefield has evolved.

In 1995 KCGM completed tailings disposal in the Oroya TSF, and groundwater levels in the vicinity fell over the next few years as this TSF dried and seepage losses eventually ceased. Groundwater production in the vicinity also increased as more production bores were established. As a consequence of these activities, groundwater levels fell by over 6 m on the eastern side of the Oroya TSF between 1995 and 2000.

By 2000 KCGM had established several production bores in the central floodway area between the TSFs. The effect of these bores is apparent in the general declines in groundwater levels that occurred in this area between 1995 and 2000.

The largest increases in groundwater levels between 1995 and 2000 occurred near the southern corner of the Fimiston II TSF. Groundwater levels in this area increased by up to 18 m during this period. Additional production bores were established in this area, and this resulted in groundwater levels declining by over 4 m by 2005.

The main changes in groundwater levels between 2000 and 2005 were a decline of up to 4 m in the central floodway area between the TSFs, and rising levels on the eastern side of the Fimiston II TSF.

Figure 7 presents contour plans of the depth to the water table in 1995, 2000, and 2005. In 1995 the water table throughout the central floodway area was at relatively shallow depths, ranging between 2 m and 6 m. Subsequent groundwater production by the Eastern Borefield caused the water table to decline, and by 2005 the depth to the water table in the central floodway area was greater than 8 m.

The 2005 contour plans indicate that there are some areas around the Fimiston II TSF in particular where the water table is at a relatively shallow depth. KCGM is in the process of increasing the production capacity in these areas to lower the water table in accordance with criteria established in the SGMP.

4.3 Groundwater Quality Data

The most apparent indicator of seepage from the TSFs in the shallow groundwater is salinity. Cyanide concentrations in groundwater samples tend to be relatively small (generally <1 mg/L total cyanide), and are more than two orders of magnitude less than the cyanide concentration in the supernatant liquid discharged to the TSFs and the water collected in the TSF decant ponds. In addition, cyanide would tend to degrade in the naturally acidic subsurface environment.

Figure 8 presents contour plans of the distribution of total dissolved salts (TDS) concentration in groundwater samples collected in 1995, 2000, and 2005. As expected, the largest TDS concentrations occur in samples from bores located close to the TSF walls. TDS tends to decrease in directions away from the TSFs, indicting that seepage is mixing with the natural groundwater and dispersing in the direction of flow.

While the production bores located in the central floodway area have successfully lowered groundwater levels, they have also attracted some of the TSF seepage. This has caused groundwater salinity to increase slowly in some parts of the central floodway.

5 SUMMARY

KCGM's Eastern Borefield is located in the vicinity of the Fimiston I and Fimiston II TSFs and the now decommissioned Oroya TSF. The Eastern Borefield has been established progressively since mid-1993, and by December 2005 consisted of 116 production bores. Groundwater is also being intercepted by five trenches near the TSF walls.

In 2005 KCGM prepared a Seepage and Groundwater Management Plan to oversee the planning and management activities associated with controlling groundwater around the Fimiston I and Fimiston II TSFs (KCGM, 2005). The SGMP was implemented in the last quarter of 2005, and requires KCGM to collect particular data and prepare reports presenting the results of monitoring and management activities. The SGMP is subject to independent audit and review annually.

The main function of the Eastern Borefield is to control groundwater levels in the vicinity of the Fimiston I and Fimiston II TSFs, and prevent the stressing or killing of vegetation. The SGMP has identified the vegetation assemblages in the area as the main environmental value requiring protection from the adverse effects of seepage. Protection of the vegetation in this area requires the water table to be maintained at a sufficient depth below the natural surface to avoid saturating the root zone. The SGMP has established minimum acceptable depths to the water table and trigger (action) levels of 4 m and 6 m. When monitor bore data indicate the water table is rising and approaching these depths, action is taken to increase the groundwater pumping rate and arrest or reverse the rising groundwater level trends.

The volume of groundwater produced annually by the Eastern Borefield has increased in most years since 1993. Annual production in 2005 was 2,701 ML (86 L/sec average), and the total volume of groundwater produced to December 2005 was 19,155 ML.

Operation of the Eastern Borefield has caused groundwater levels (and the water table) to decline in the central floodway area between the Fimiston I and Fimiston II TSFs and the former Oroya TSF. In 2005 the depth to the water table over a large part of this area was greater than 8 m.

The most apparent indicator of the occurrence of seepage from the TSFs in the shallow groundwater is salinity (expressed as TDS). Cyanide concentrations in groundwater samples tend to be relatively small (generally <1 mg/L total cyanide), and are more than two orders of magnitude less than the cyanide concentration in the supernatant liquid discharged to the TSFs and the water collected in the TSF decant ponds. The largest TDS concentrations of >100,000 mg/L occur in monitor and production bores close to the walls of the TSFs. TDS concentrations tend to decrease in directions away from the TSFs, indicating that seepage is mixing with the natural groundwater.

While the production bores located in the central floodway area have successfully lowered groundwater levels, they have also attracted some of the TSF seepage. This has caused groundwater salinity to increase slowly in some parts of the central floodway.

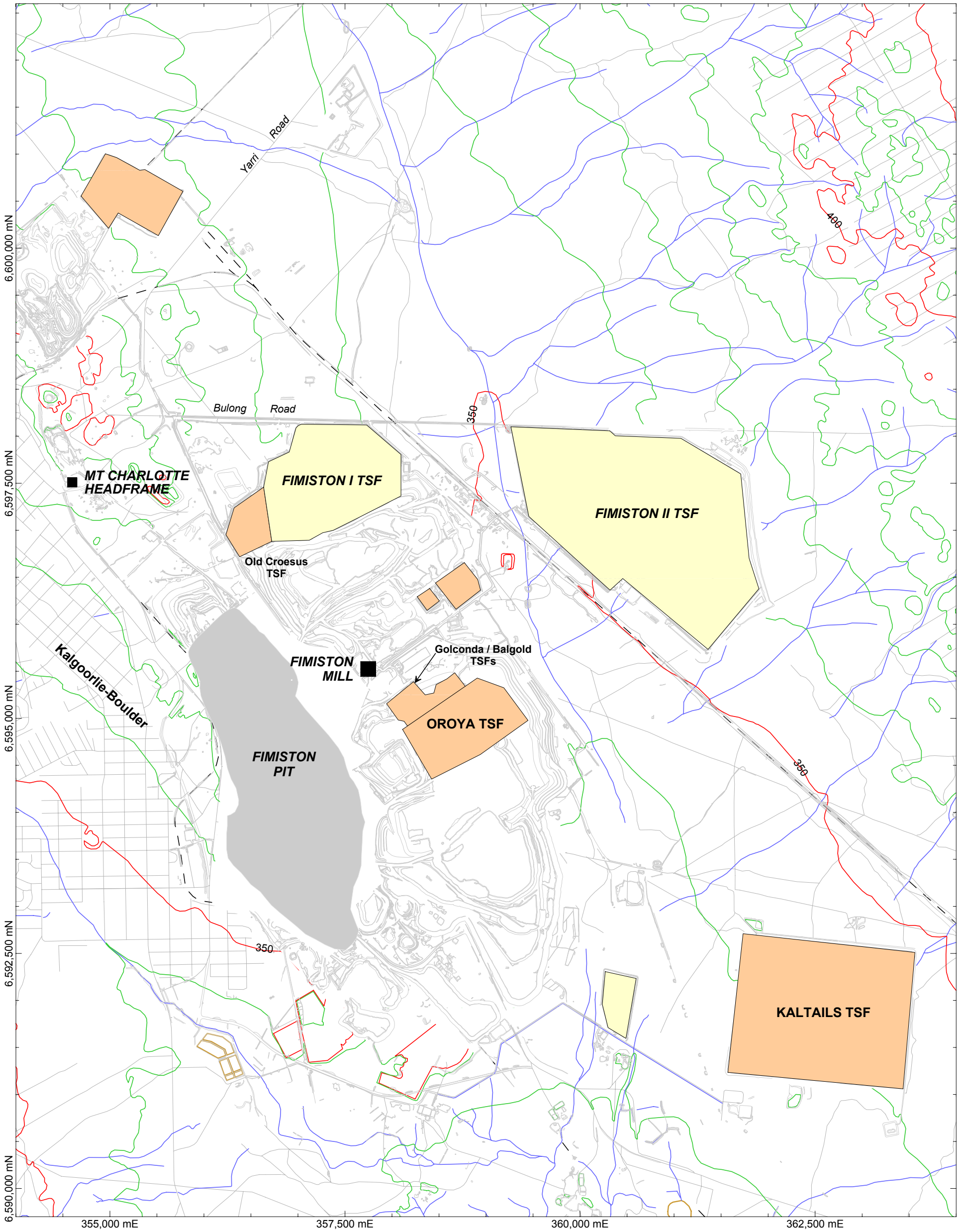
The objective of the SGMP is to reduce groundwater levels in the vicinity of the Fimiston I and Fimiston II TSFs to historic levels that occurred prior to the commencement of KCGM's tailings disposal operations. In reality this is a long term objective that will require the Eastern Borefield to be operated for a period after tailings disposal has ceased.

Peter Clifton & Associates

P M Clifton
Director

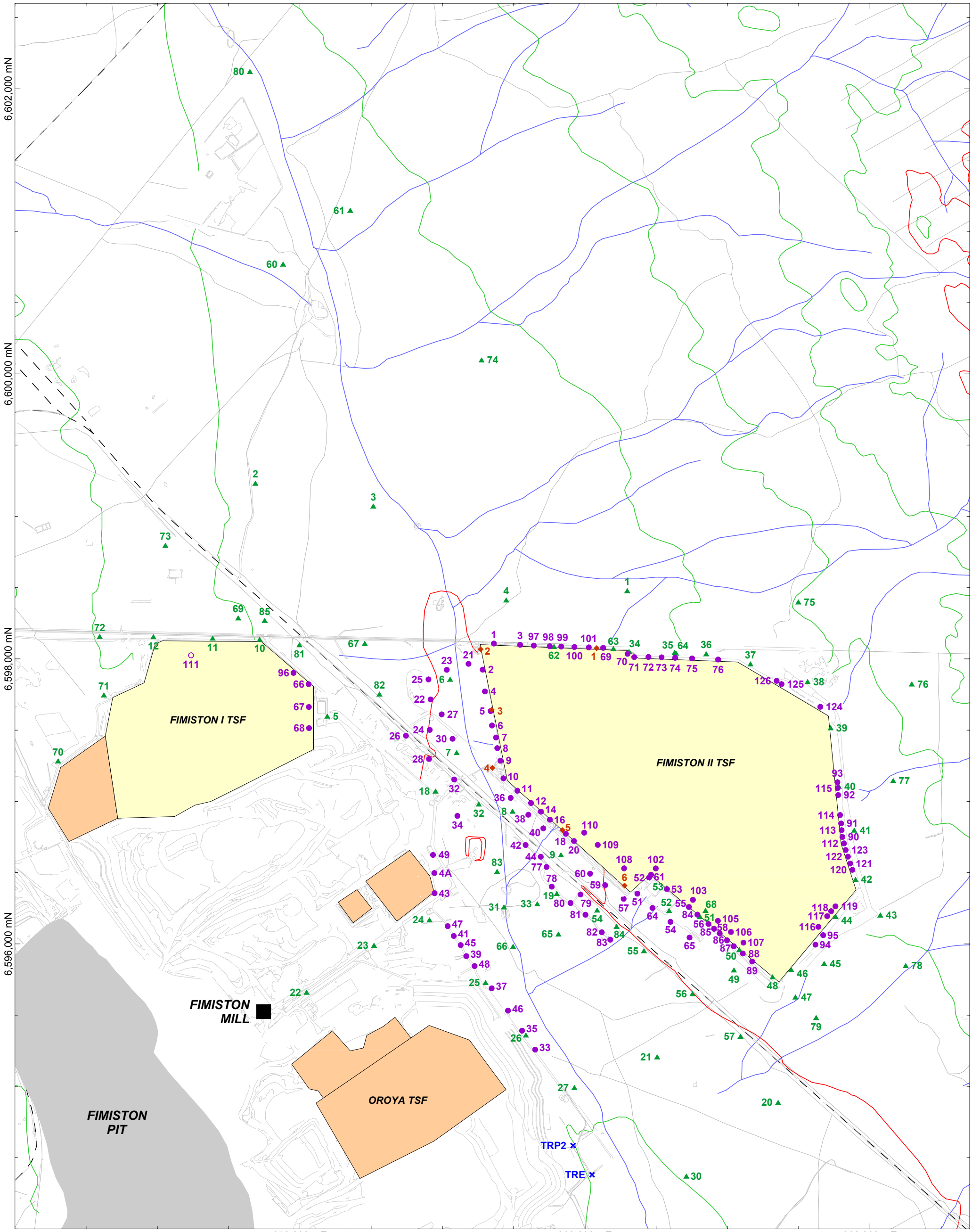
REFERENCES

KCGM, 2005, "Fimiston Operations Seepage and Groundwater Management Plan", prepared by Kalgoorlie Consolidated Gold Mines Pty Ltd, September 2005.



Grid coordinates: MGA94, Zone 51

FIGURE 1
Location of KCGM Fimiston Operations
and Tailings Storage Facilities



Scale 1:25,000

0m 500m 1000m

Grid coordinates: MGA94, Zone 51

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KCGM infrastructure from KCGM Survey Department

- Production Bore, "PB F" series
- "PB F" series bore, not equipped
- Monitor Bore, "MB F" series
- Monitor Bore, "NTD" series
- Monitor Bore, other

FIGURE 2

Eastern Borefield
Production and Monitor Bore Location Plan

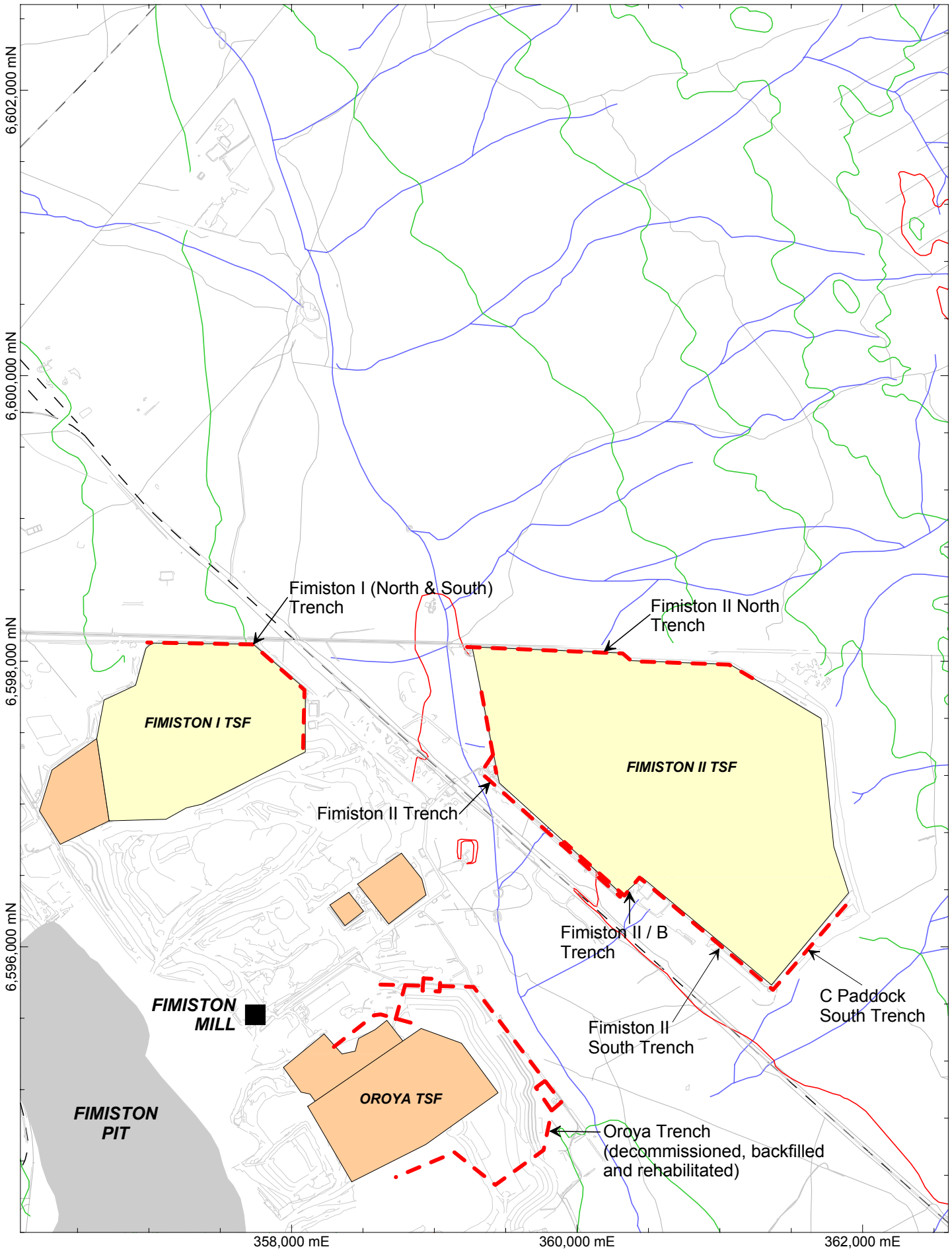

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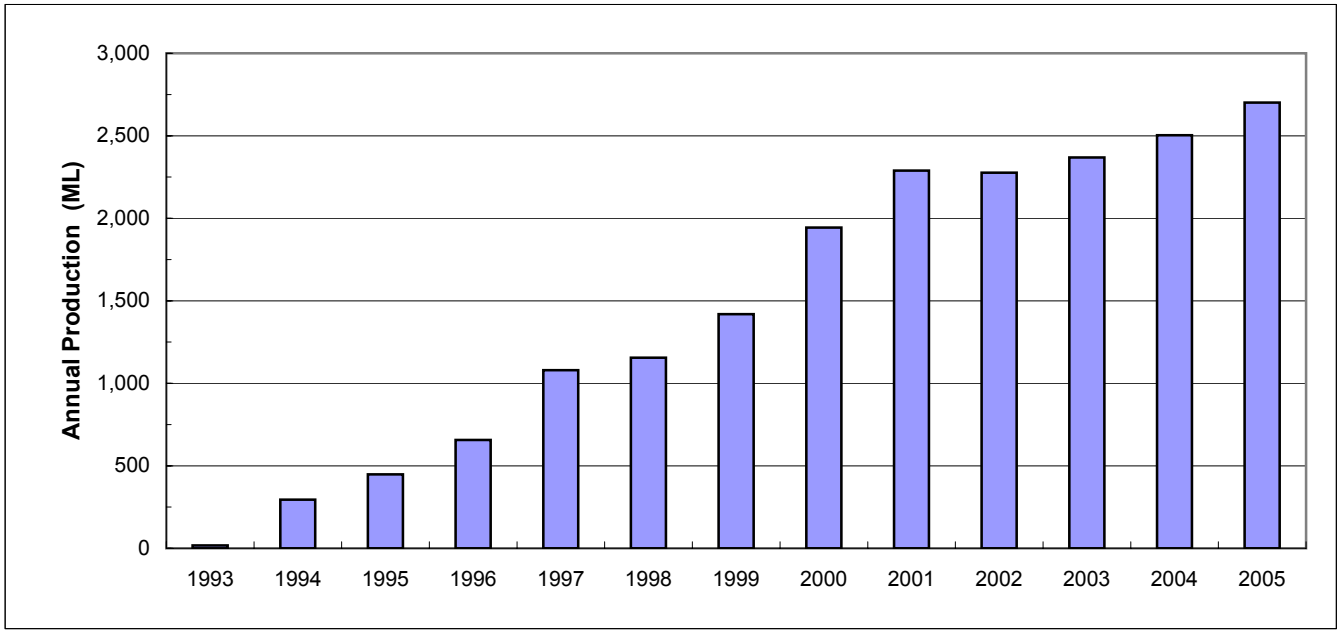
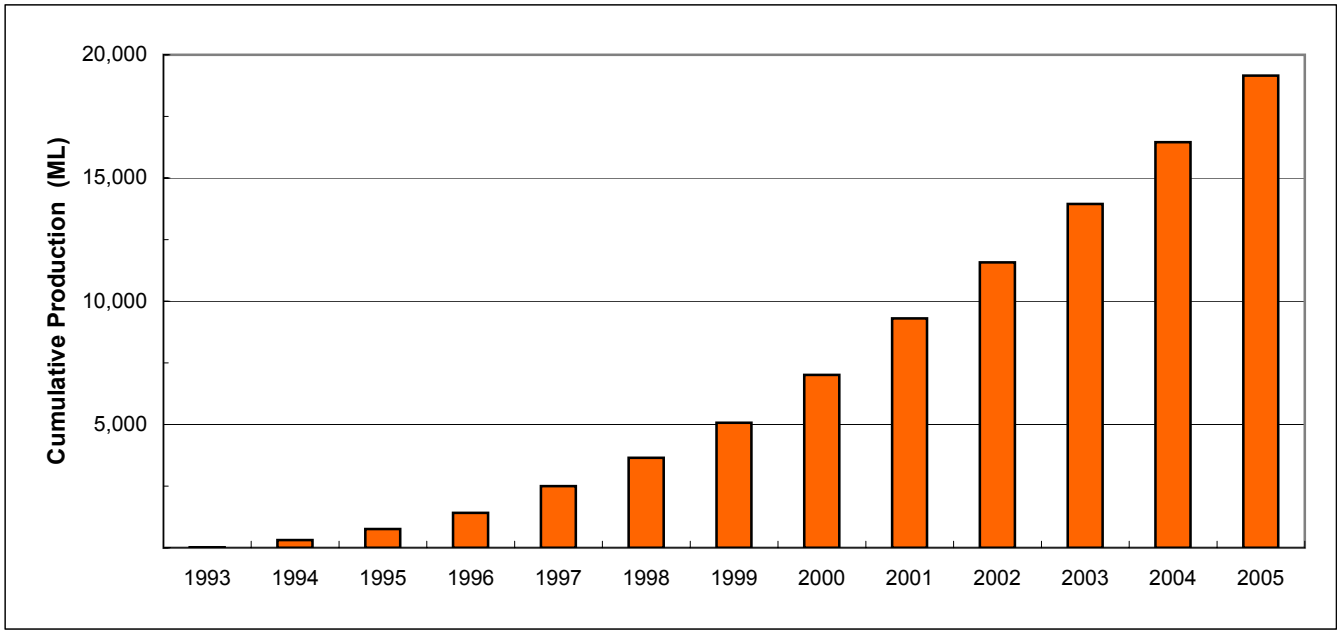
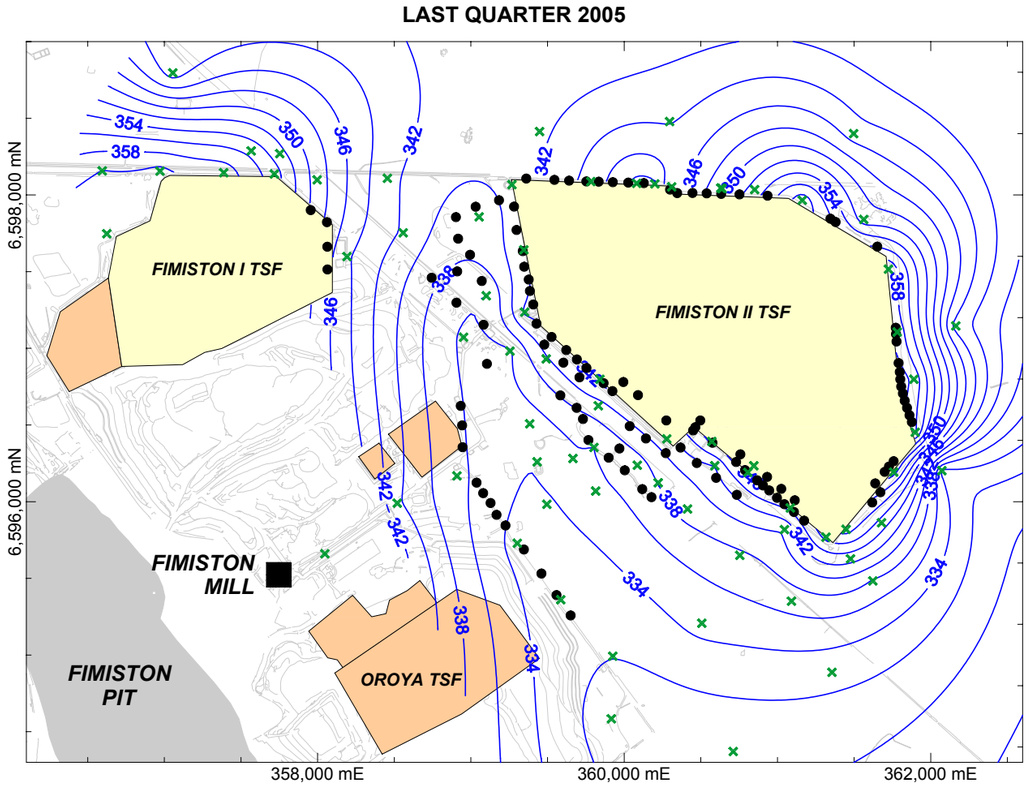
FIGURE 3
Eastern Borefield
Seepage Interception Trench Location Plan

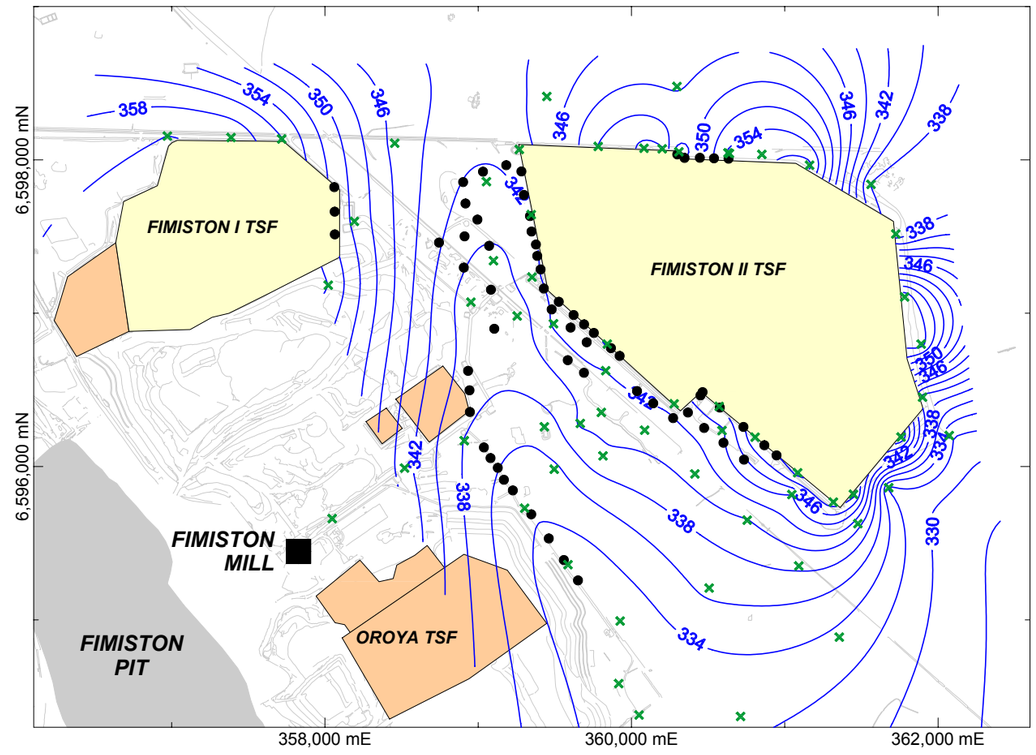


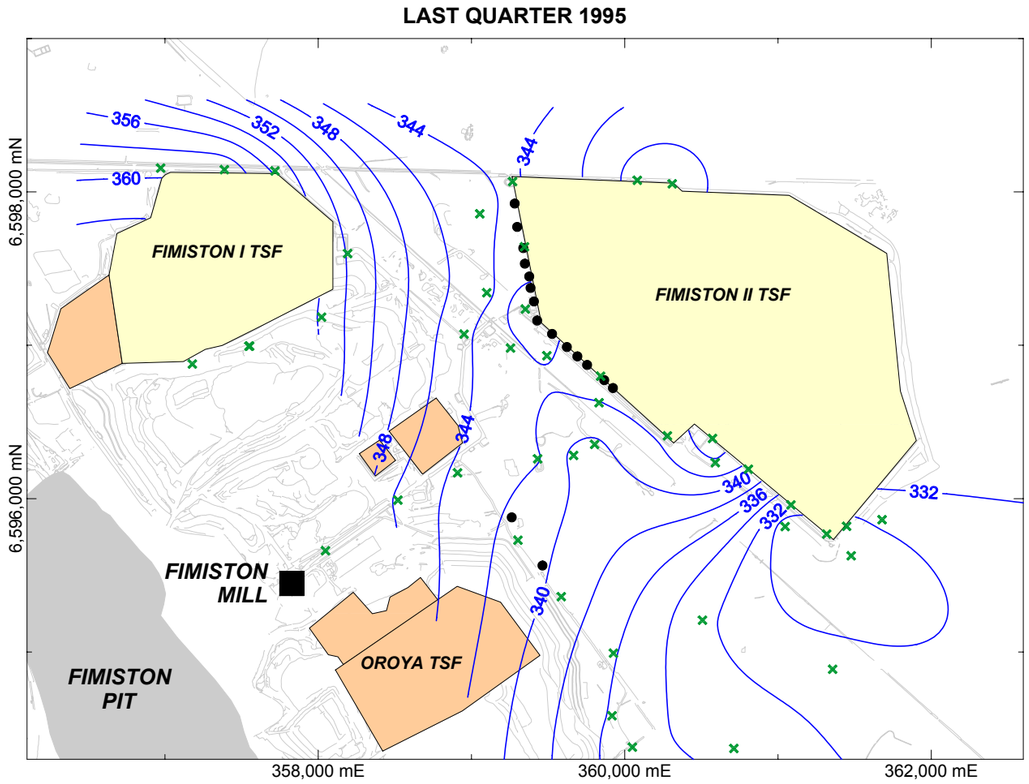


Period	Annual Production (ML)	Cumulative Production (ML)
Sept 1993 to Dec 1993	18	18
Jan 1994 to Dec 1994	295	312
Jan 1995 to Dec 1995	448	761
Jan 1996 to Dec 1996	657	1,418
Jan 1997 to Dec 1997	1,080	2,497
Jan 1998 to Dec 1998	1,155	3,653
Jan 1999 to Dec 1999	1,419	5,071
Jan 2000 to Dec 2000	1,944	7,015
Jan 2001 to Dec 2001	2,289	9,305
Jan 2002 to Dec 2002	2,276	11,581
Jan 2003 to Dec 2003	2,368	13,949
Jan 2004 to Dec 2004	2,504	16,453
Jan 2005 to Dec 2005	2,701	19,155

EASTERN BOREFIELD GROUNDWATER PRODUCTION SUMMARY | **FIGURE 4**







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Scale 1:40,000

0m 500m 1000m

Grid coordinates: MGA94, Zone 51

KCGM infrastructure from KCGM Survey Department

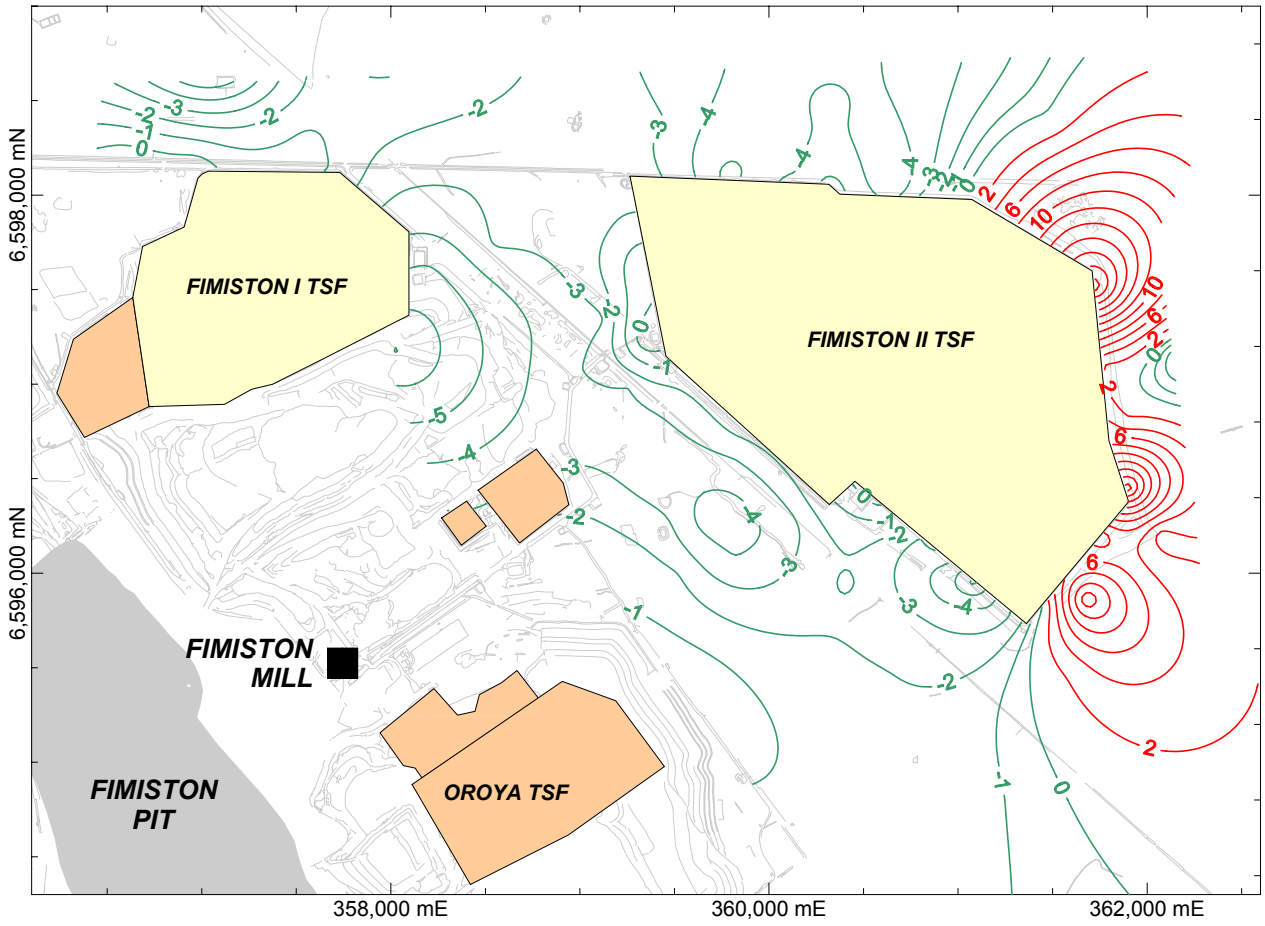
Groundwater level contours in mAHD

- Active production bore
- Monitor bore used to develop groundwater level contours

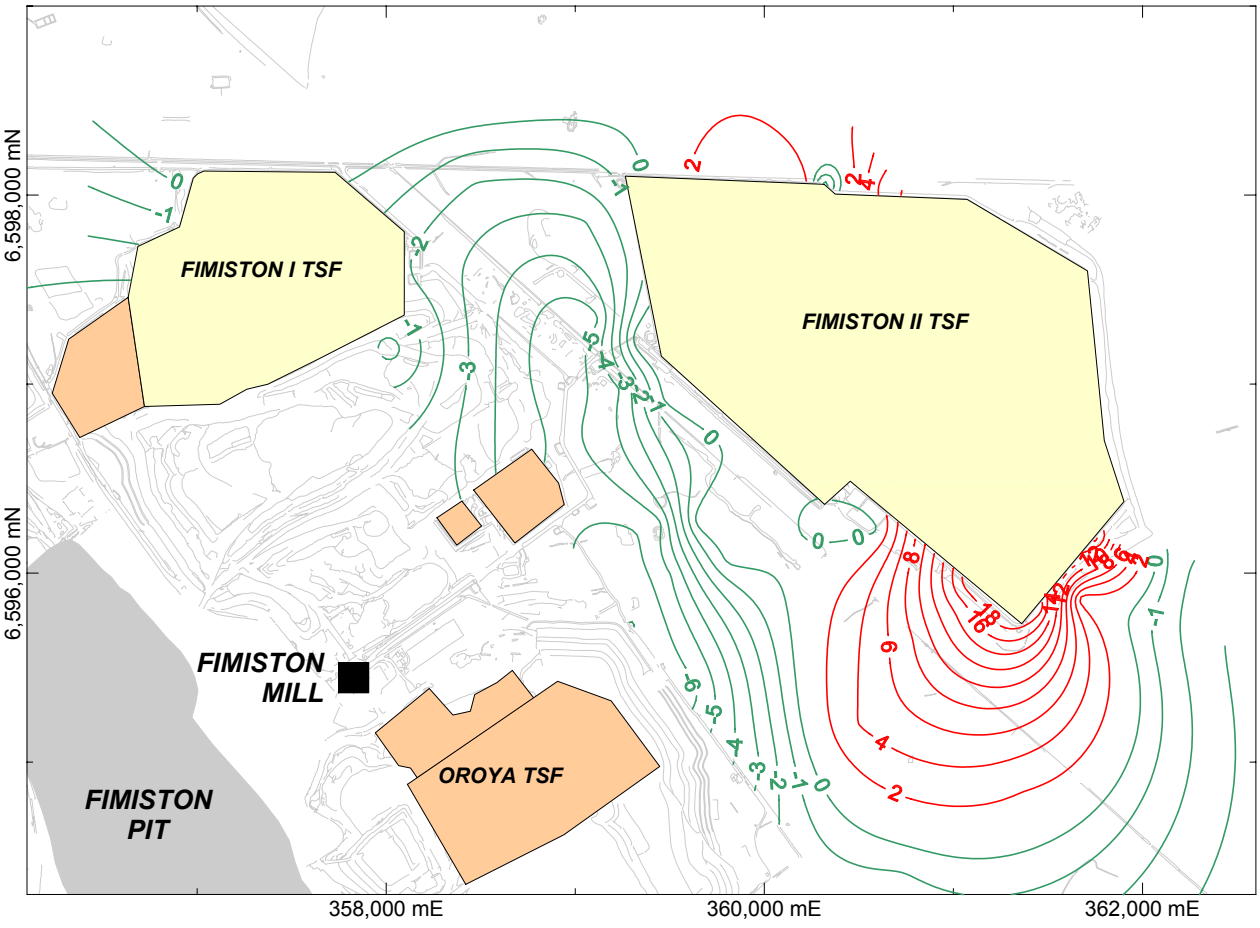
FIGURE 5

Contour Plans of Groundwater Levels in 1995, 2000, and 2005

CHANGES IN GROUNDWATER LEVELS 2000 TO 2005



CHANGES IN GROUNDWATER LEVELS 1995 TO 2000



Scale 1:40,000

0m 500m 1000m

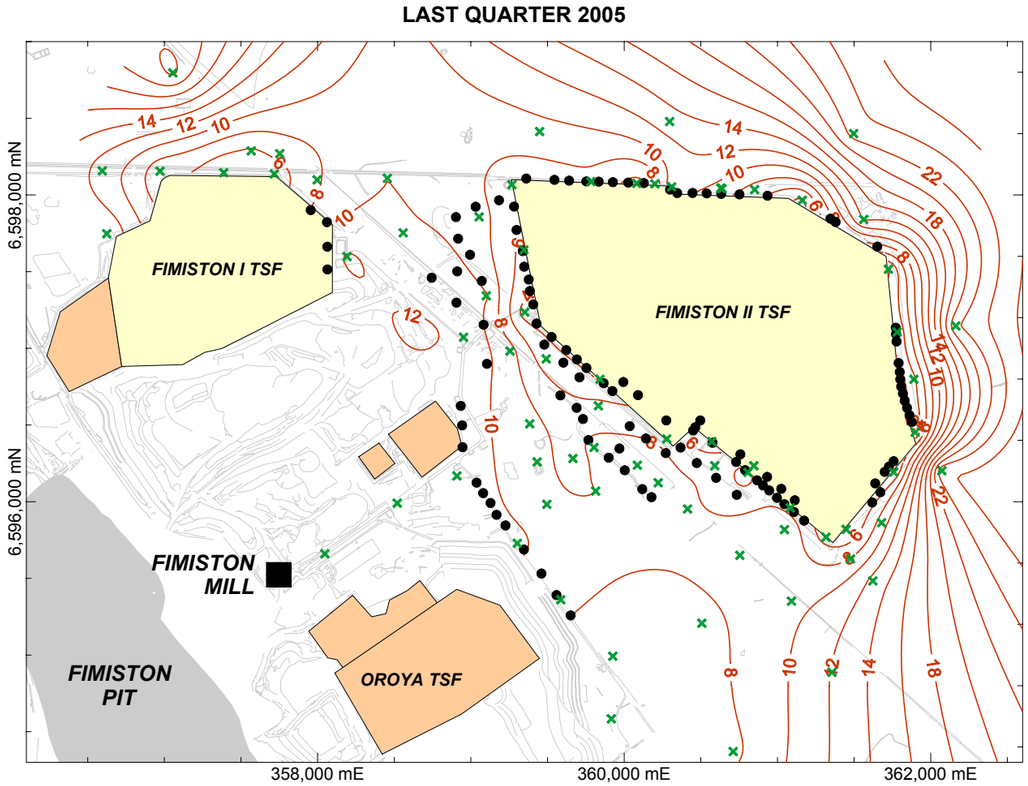
Grid coordinates: MGA94, Zone 51

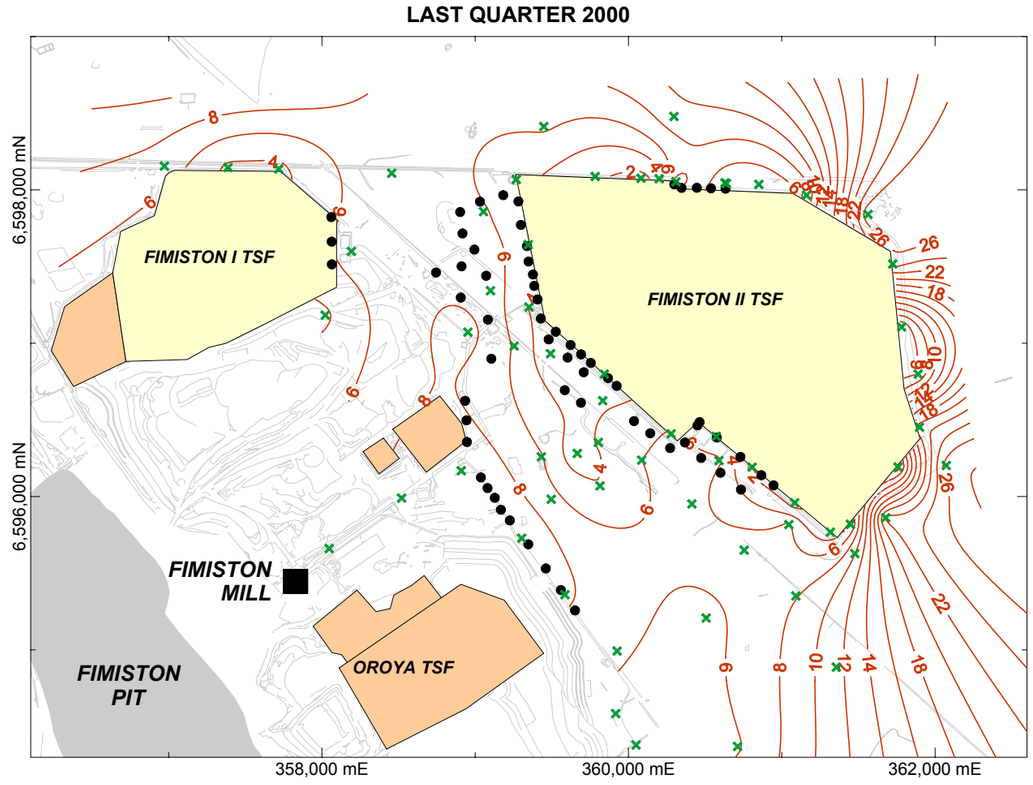
KCGM infrastructure from KCGM Survey Department

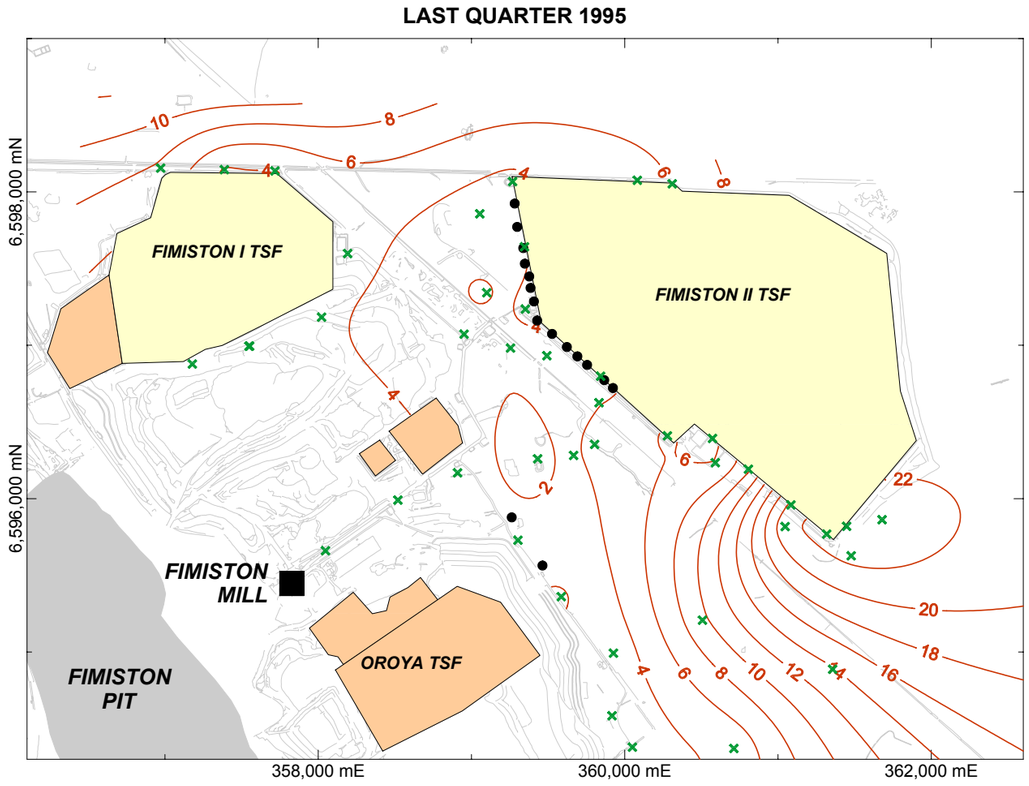
Contours in metres
Negative values indicate groundwater levels have decreased
Positive values indicate gorundwater levels have increased

FIGURE 6

Contour Plans of Changes in Groundwater Levels







Scale 1:40,000

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Grid coordinates: MGA94, Zone 51

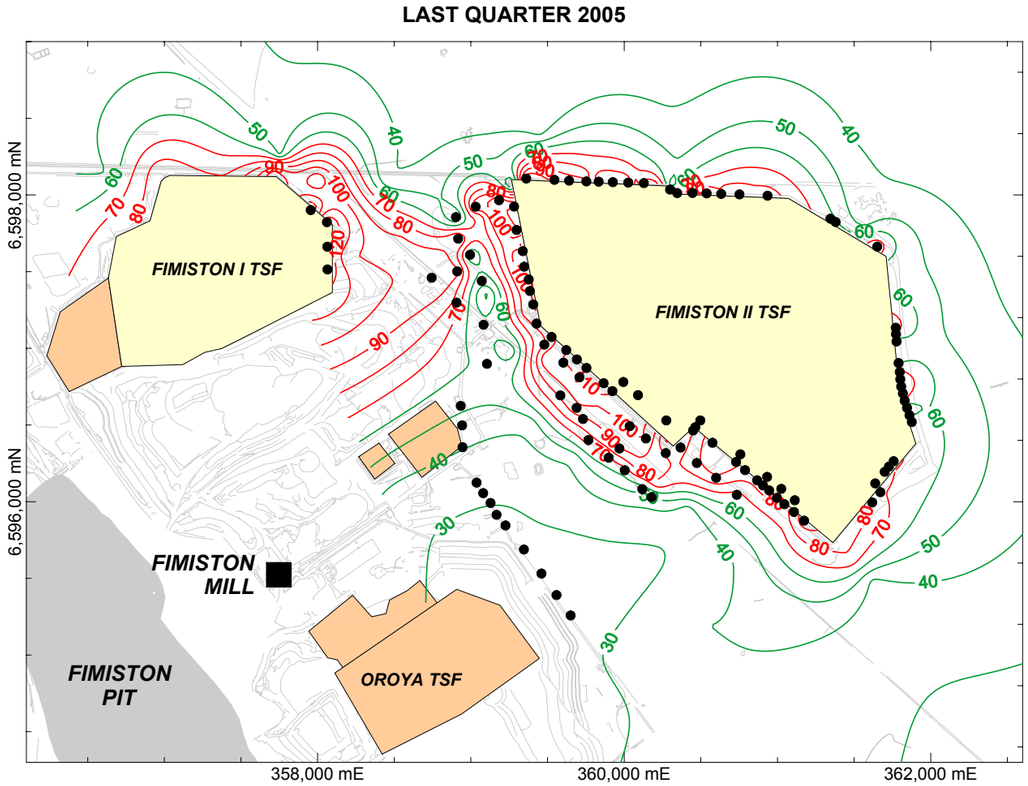
KCGM infrastructure from KCGM Survey Department

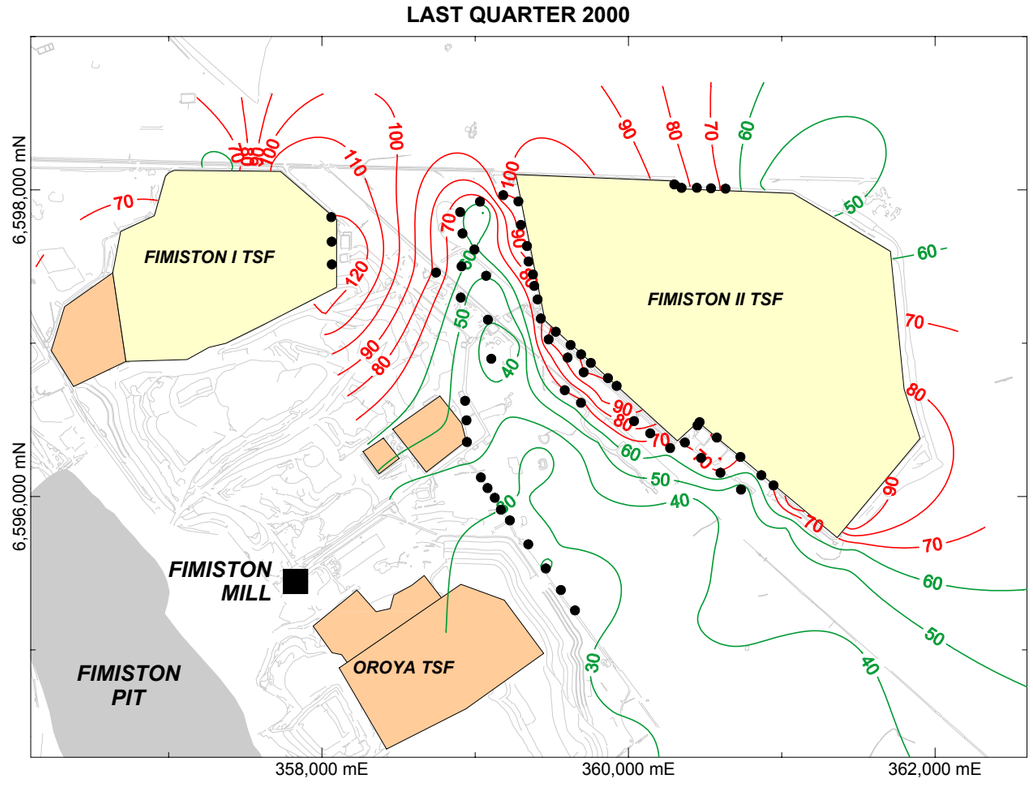
Water table depth contours in metres below natural surface

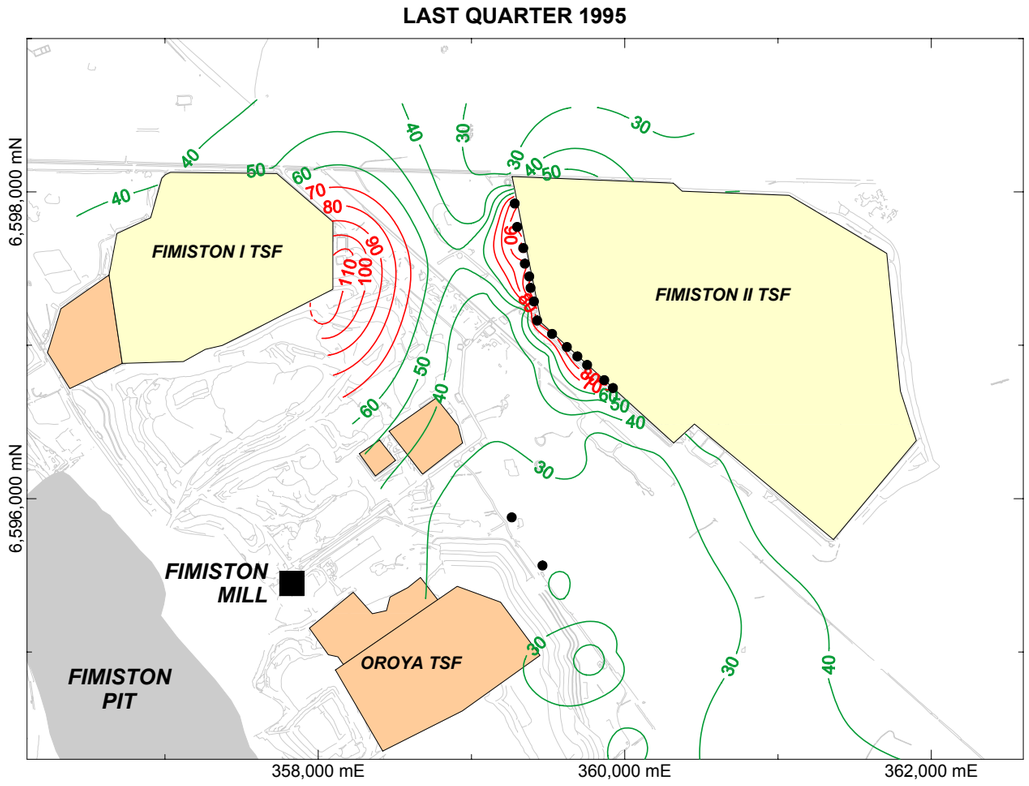
- Active production bore
- Monitor bore used to develop groundwater level contours

FIGURE 7

Contour Plans of Depths to Water Table in 1995, 2000, and 2005







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Scale 1:40,000

0m 500m 1000m

Grid coordinates: MGA94, Zone 51

KCGM infrastructure from KCGM Survey Department

Total dissolved salts concentrations in g/L

● Active production bore

FIGURE 8

Contour Plans of Total Dissolved Salts Concentrations in 1995, 2000, and 2005